INTELLECTUAL PROPERTY RIGHTS AND NATIONAL INNOVATION SYSTEMS. Some lesson from the Mexican experience.

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During the second half of the 1980s, important changes took place in the regulatory framework for intellectual property rights (IPRs) in the industrialized and less developed countries. The reasons behind these changes were, on the one hand, governments' and firms' growing acceptance of the importance of knowledge assets in international trade; and, on the other, the US government's pressure during the GATT negotiations — the Uruguay Round — to harmonize institutional norms regarding intellectual property rights. Underlying this proposal, most developed economies support the idea that the heterogeneity of IPRs in GATT member countries produces serious distortions in world trade, and particularly discourages foreign direct investment. The debate has concluded with an international proposal that was called *Trade Related Aspects of Intellectual Property Rights* (TRIPS). This initiative was passed in 1993, when GATT/WTO member countries approved TRIPS during the Marrakech Conference. Mexico has accepted this regulatory frmaework and introduced changes in the domestic law that regulates IPRs.

This new norm has been introduced, together with the consolidation of the trade reform which began during the second half of the 1980s, and which concluded with the signing of NAFTA and Mexico's membership in the OECD. Mexico is a country that has implemented important economic reforms as trade liberalization, privatization of state companies and economic integration with the USA and Canada (NAFTA). Since it was recognised as an engine for economic growth in the 1940s, Mexican manufacturing industries have been growing under a regime of intensive protection. The orientation maintained a strong inward bias, at least until the 1982 financial crisis. In contrast, the more recent period has undergone a major shift in its orientation: the nation faced a “radical shock” involving new economic reforms, in which the primary objective was to generate the conditions for faster economic growth and a new pattern of economic development. This shock should provide an effective way to retool economic activities, by combining a favourable environment in terms of relative prices with an improvement in the incentives for technology upgrades. Since the beginning of this liberalisation period, and combined with the further privatisation of services, Mexican industry has experienced a profound structural transformation, and one of the major consequence has been a steady internationalisation process that is based on an external performance which the nation never had experienced before.

The central idea of this paper is that these economic changes and the impact of the new IPR framework can not be understanding outside of the behavioural patterns and linkages that characterize the Mexican innovation system. Thus, the analysis of the new IPR framework is applicable to a collection of different agents –resident, no residents, transnational companies, local firms, universities, research centres and sectors- and the interactive linkages between them. In a such context, this paper argues that analyzing the experience of the new intellectual property law the use of patents is a weak incentive for the local creation and diffusion of technology; since, it does not favour the local efforts on R&D -in local firms and thorough FDI of transnational companies- and relationships linking the agents of innovation system.

In general, it is argued that the new IPR's framework and the economic reforms do not provide incentives for the upgrading of technological capabilities in the Mexican system. Thus, both set of incentives interacting between them reinforce adverse mechanisms for the diffusion of innovation within the system. Section one presents a definition of national innovation systems and relates this with the institutional framework promoted by a homogenization of the IPRs regime. Section two describes the differences in patent systems considering the flows of three categories: (i) applications for patents from *residents* (domestic); (ii) applications for patents from *non-residents* (usually transnational foreign companies); (iii) *external* applications for patents (local companies) or any other agent that might request a patent abroad. The first two kinds are registered inside each country's borders while external patents are registered in a wide set of countries whose degree of dispersion depends on each country and on the period of time dealt with. According to the above taxonomy, in this section it is also described how different innovation systems explain differences in performance of paten systems. In the following three sections, our analysis focuses on the incentives promoted by the IPRs regimen introduced in Mexico and its impact on the innovation system. Here, a broad comparative analysis between the innovative performance of patenting system in Mexico and Korea is presented. Section 6 is dedicated to a brief conclusion.

Innovation Systems and Intellectual Property Rights

In modern innovation theory, the firms' strategic behaviour and alliances , as well as the interactions between firms, research institutes, universities and other institutions, are at the heart of analysis of the innovation process. More specifically, in the concept of a national innovation system, as introduced by Freeman (1987) in the mid-1980s and as further developed by Nelson (1993), Lundvall (1993), Metcalfe (1995), Edquist (1997), Cimoli and Della Giusta (2000), innovation is considered an interactive process in which the above-mentioned features are captured. In general terms, most of the contributions cited above support the idea that the main building blocks in a National Innovation System are articulated by a collection of different agents and their interaction.

Following the concepts introduced in Freeman (1987) and Nelson (1993), and within national boundaries, analysis is carried out on a set of actors (firms and, particularly, other institutions such as universities, research organisations, etc.), as well as on the links between these actors in the innovation and diffusion processes. Metcalfe (1995) provides the following policy-oriented definition of a National Innovation System: a “set of institutions which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation process.” He argues that the nature of each NIS fundamentally is shaped by the division of labour and the peculiarities of information, which cause non-market means to predominate in the co-ordination process. The institutions that form this group (private firms, universities, other educational institutions, public sector research labs, private consultants, professional societies and industrial research associations) “make complementary contributions, but they differ significantly with respect to motivation and in commitment to the dissemination of the knowledge they create

The evolutionary foundations which account for the characteristics of national systems of production and innovation develop through to the ideas that firms are repositories of knowledge, that they are nested in networks of linkages with other firms and also with other non-profit organisations (networks which enhance the opportunities facing each firm to improve their problem-solving capabilities), and finally that there exists a broader notion (at a wider level of aggregation) of embeddedness of microeconomic behaviours into a set of social relationships, rules and political constraints (Cimoli and Dosi 1995, Dosi, Nelson and Winter 1982). Thus, in general, Nations are represented as *containers of microeconomic behaviours* characterised by particular modes of institutional governance, that to a certain extent, make them diverse self-reproducing entities. Indeed, there is an element of nationality which is provided by shared language and culture, as well as by the national focus of other policies, laws and regulations, which condition the innovative environment (Metcalfe, 1995). Together they contribute to the shaping of the organisational and technological context within which each economic activity takes place. In a sense, they set the opportunities and constraints facing each individual process of production and innovation - including the availability of complementary skills, information on intermediate inputs and capital goods and demand stimuli to improve particular products.

Even more so, at a system level, the interpretation presented here is consistent with, and indeed, is a complement to institutional approaches that build on the observation that markets do not operate apart from the rules and institutions that establish them and that "the institutional structure of the economy creates a distinct pattern of constraints and incentives," which defines the interests of the actors, as well as shaping and channelling their behaviour (Zysman 1994: pp. 1-2).

The IPRs regime adopted should be viewed as an institutional change that impact most of innovative activities. Most of the promoters of the homogenization of the IPRs regime argue that the incentives contained in this will stimulate the creation of a market for knowledge, where investment in R&D and its intrinsically uncertainty can be paid back (Foray 1993, David 1992).

Setting up a IPRs regime to protect innovation and promoting its homogenization across countries, more incentives to increase firms R&D expenditures and knowledge activities should be obtained. Some general conjectures support the above: i) a homogenization of IPRs is the basis for the development of a market of knowledge which instruments are patents, ii) a system of IPRs that protect innovation will better stimulate the public welfare in the world economy, iii) a such pattern of incentive stimulate better the realization and risks sharing of the activities on R&D activities. Most of these points support the argument that protection is the better incentive to promote innovation. Indeed, this institutional design of incentives fit very well with innovation systems in developed economies; where we have the concentration of most R&D activities and technological efforts.

A first point to be observed is that countries do not depart from the same line. They have differences in their innovation systems (Cimoli and Dosi 1995). The differences that characterize a developed country with respect to a developing one are: i) higher R&D expenditures (public and private); 2) more recourses and solid institutions dedicated to training of human resources and universities; 3) higher articulation in networks that interlink institutions and production syste; 4) higher concentration of the innovative leader at the world level, etc. In a system like this, a IPRs regime that incentive protection of innovators and their activities is coherent with an improvement of the welfare in term of the benefit that a society has from the introduction of new goods and production process.

The case of developing countries is substantially different[1]. The recent literature on these themes confirms that the impact of the IPRs reforms on developing countries can produce adverse mechanism to promote innovation and growth (Combe and Pfister (2000)). Particularly, in the case that the incentives promoted by the IPRs regime are superposed to the market driven reforms. Thus, on the one side, these economies have adopted a IPRs regime that incentive the protection of innovative activities; and, on the other, they adopted also liberalization policies to allow a higher diffusion of trade and capital movements. Some general impacts can be summarized as follows:

i)If a large number of knowledge content products are produced in developed countries at a higher price, this specialization pattern will produce a deterioration of the terms of trade of developing countries affecting their gorth possibilities. The static welfare effect is negative for developing economies.
ii) The relation between IPRs protection and FDI is ambiguous. On a one side, FDI could increase if the protecting IPRs regime is adopted but, on the other, the is no guarantee that FDI diffuse innovations locally.
iii) The relation between IPRs and technological effort seems to be very weak. Most developing economies have not increased their efforts after the adoption of the IPRs regime.
iv) The superimposition of free trade and IPRs regimes reinforces adverse incentives for the upgrading of local technological capabilities.

[1] See among others: Braga and Willmore (1991), Diwan and Rodrik (1991), Bertin and Wyatt (1988), Vaistos (1971).

In particular, this last finding is confirmed in Latin American countries. These have changed most of the elements and interactions that configure their innovation systems (Cimoli 2001, Cimoli and Katz 2001). For example, the role-played by MNCs and large domestic conglometere, the presence of the state in the economy, the regulatory mechanism in services activities and so on. Thus, in a world of increasing returns to scale in production of knowledge, at the level of the firm, and of synergies and interdependencies between firms and other repository institutions involved in the 'production' of skilled man power and technology, (such as universities, public R&D laboratories, and so forth), the conditions are given for the globalisation process to induce a dualistic world-wide pattern of production organisation. In such dual pattern, R&D and engineering activities increasingly will tend to concentrate in developed countries while developing economies will remain 'locked-in' in the production of low value added industrial 'commodities' as well as in 'maquila'-type activities. We have also seen that in many cases this has involved the transferring abroad of many 'in house'- performed R&D and engineering efforts. The local operation has turned more into the nature of an assembly activity, strongly based on imported parts and components as well as on externally supplied technological and engineering services. This mechanism is likely to induce an increasing isolation of peripheral countries from the world of technology generation.

Asymmetries in Patent Systems (PS)

Compiled from WIPO (World Intellectual Property Organization) information, table 1 confirms that Latin American countries represent almost a third of the flow of applications for patents. Mexico's situation is noteworthy in that its volume of applications (15 percent) is higher than Brazil's (13.5 percent). Patenting data from Japan and Korea indicate that these economies maintain a leadership (Aboites 2001).

Table 1 Patents applications

Countries	1997	E.U. = 100
North America:		
U.S.	236,692	100.0
Canada	54,446	23.0
Latin American		
Mexico	35,932	15.2
Brazil	31,983	13.5
Argentina	6,683	2.8
Europe		
Germany	175,595	74.2
England	148,209	62.6
France	112,631	47.6
Spain	113,767	48.1
Portugal	106,687	45.1
Greece	82,443	34.8
Sudeste Asiatico		
Japan	417,974	176.6
Corea	129,982	54.9
Sources: WIPO (1988), Intellectual Property Statistics and OEA (1999), Indicadores tecnologicos de AL.		

The countries patent systems display highly contrasting behaviors under the effect of institutional homogenizing of the IPRs regulatory frames. Although the changes in the regulatory frame agreed upon by the WTO (World trade Organization)—the TRIPs, Trade Related Intellectual Property Right—took place in 1993 (Marrakech), it is a fact that from the late 80s to the early 90s they were already under way in the majority of the countries studied. Mexico, for example, approved them in 1991. This is why for the purpose of studying the evolution in the flow of applications for patents, the period of study that goes from 1981 to 1997 was divided in two: the first (1981-1989) covers the years before the TRIPs reforms; the second period (1990-1997) covers the years after the changes in them took place.

The intensity of variations registered in the basic flows of applications for patents of the PS during the last two periods was taken into consideration (Aboites 2001, Aboites and Soria 1999). They were observed in order to determine the possible existence of a certain degree of continuity or, on the contrary, of a significant inflexion in the flows of patents. For this purpose two ambits of the PS were considered: internal (applications for patents from residents and non-residents) and external (applications for patents from abroad). The first two flows are analyzed with information from WIPO, while external patents are those granted abroad of each economy (an analisis exclusively based on USPTO,US Patent and Trademak Office, is presented in the next section). Three types of behaviour were defined based upon the evolution of the flow of residents' patents, non-residents patents and external patents (Aboites 2001). These three types of behaviour are: (i) *Stable* PS (France and Uk), (ii) *Converging* PS (US, Canada, Germany, Japan and Korea) and *Divergent* PS (Mexico, Brazil, Argentine and Spain). Each was characterized as follows:

Stable Patents System: this is a PS whose basic internal flows (applications for patents from residents and non-residents) do not suffer any significant modification when passing from one time subdivision to the next. They preserve—within a certain range—the previous trend. This internal continuity shows us that the changes in the regulatory frame (implementation of the TRIPs of the WTO) did not alter domestic trends registered in the first time subdivision. On the other hand, there was a significant increase in the flow of patents in the external ambit between one time subdivision and the other. This shows that in a country with a *stable* PS there were no significant changes in internal trends although externally modifications did occur.
In other words, they kept the same dynamism displayed before the amendments to the regulations that took place in the 80s and after the changes in the TRIPs during the 90s.

Converging Patents System: its two basic flows of applications for patents have similar trends and this tendency is emphasized during the second time subdivision; however, in most of them, applications from resident increase their relative share. Besides, the flow of external patents presents a significant increase when passing from one time subdivision to the next. In quantitative terms the flows of internal applications (residents and non-residents) increase their intensity above two percentual points in the average rate of growth; also a positive and considerable change was registered between the two analyzed time subdivisions.

Divergent Patents System: here the two basic flows of applications for patents show a gap when passing from the first to the second time subdivisions. Such behavior is due, on one hand, to the increase in the flow of applications from non-residents. On the other hand, there is a stagnation or contraction in the flow of applications from residents. The fact that neither the applications from residents or the external applications are sensitive to institutional changes implies that in this PS promoted by the IPRs regime are far from contributing to the stimulation of inventive activity. It seems that this new incentives addressed to protect innovation have indeed inhibited it.

A general trend indicates that the harmonizing of IPRs produced an unprecedented increase in patenting around the world. This trend is led by industrialized countries, especially by the three regions that are the stepping-stone of the Triad and the globalization of world economy where Latin America does not take part as originator of patents, notably Mexico, but as an ever-expanding recipient of flows of technology coded in patents. This is another profound difference between *divergent* PS (Latin America) and *converging* PS. This is also valid for *stable* PS. It should be kept in mind that *stable* PS like converging PS and unlike *divergent* PS are characterized by an increase in external applications for patents after the international change of IPRs.

Patenting in USPTO

As can be observed, the great pole of attraction is the US Patent and Trademark Office (USPTO) where the majority of technology-related transactions take place (Pavitt (1992), Narin (1997) and NSF (2000)). Here, three (Europe, US and Southeast Asia) are the most important in the world representing more than 90 percent of the total patenting registered. Dosi, Pavitt and Soete (1990) have called this group the *Innovative Countries Club*. Moreover, this select group is actually generating state of the art technologies related to information and communications, biotechnology, new materials etc. The analysis of patents granted in USPTO, carried on countries and sectors between (1980-1999), display the following main trends:

i) From the analysis of patents granted to non-residents in USPTO, we observe that in the last decades occurred both the emergence of Japan and the European decline. Subsequently, from the late 80s and associated to the changes in the regulation frame of the TRIPs, developing economies in Southeast Asia registered a rapid increase in incidence in the USPTO.

Table 2, Patents granted in the US by foreign country, 1950-1999 (shares)

	1950	1958	1965	1973	1979	1986	1995	1997	1998	1999
Australia	1.54	0.60	0.94	0.92	1.12	1.14	1.00	0.95	1.07	1.02
Austria	0.48	1.12	1.16	1.02	1.19	1.09	0.74	0.75	0.58	0.69
Belgium	1.07	1.14	1.50	1.23	0.98	0.74	0.87	1.02	1.03	0.93
Canada	11.16	7.99	7.00	6.20	4.56	4.01	4.61	4.73	4.42	4.64
Denmark	1.36	0.74	0.74	0.70	0.56	0.56	0.44	0.66	0.58	0.70

France	15.54	10.36	10.90	9.38	8.46	7.22	6.18	5.88	5.46	5.49
Germany	0.57	25.60	26.40	24.25	23.87	20.80	14.45	13.94	13.53	13.42
Italy	0.86	3.02	3.38	3.39	3.14	3.05	2.36	2.46	2.35	2.14
Japan	0.03	1.93	7.43	22.10	27.69	40.35	47.64	46.10	45.88	44.70
The Netherlands	8.10	5.71	4.15	3.03	2.80	2.20	1.75	1.61	1.82	1.79
Norway	0.95	0.61	0.42	0.42	0.43	0.25	0.28	0.28	0.29	0.32
Sweden	6.67	4.64	4.50	3.40	3.02	2.70	1.76	1.72	1.82	2.01
Switzerland	9.73	8.80	6.97	5.79	5.40	3.70	2.31	2.17	1.90	1.84
United Kingdom	36.00	23.45	20.62	12.56	10.07	7.37	5.42	5.33	5.15	5.13
Total NICs	1.41	1.31	1.71	1.36	1.45	1.50	7.53	9.55	11.26	12.23
-Mexico	-	-	-	-	0.19	0.11	0.09	0.09	0.08	0.11
-Argentina	-	-	-	-	0.13	0.05	0.07	0.07	0.06	0.06
-Brazil	-	-	-	-	0.10	0.08	0.14	0.12	0.11	0.13
-Korea	-	-	-	-	0.03	0.14	2.54	3.76	4.85	5.12
-Taiwan	-	-	-	-	0.20	0.64	3.55	4.09	4.61	5.31
-Other NICS	-	-	-	-	0.80	0.48	1.14	1.41	1.54	1.50

2) The evidence suggests that there is a substitution of mechanical for Eletric-Electronic (E-E) technologies going on now due to the emergence of the latter and the considerable withdrawal of the formers. These were at the core of innovations during the first three postwar decades through their association to capital goods in the automotive, steel, glass and other industries. This trend is associated with the emergence of a new technological paradigm based in E-E. On the other hand, Latin America maintained its low patenting activity in the USPTO, which can be interpreted as a lack of integration to that part of the world that produce knowledge.

Table 3 Patents granted in USPTO by sectors and countries

	United States	Canada	Mexico	Argentina	Brazil	Germany	England	France	Spain	Japan	Korea
1986-92											
Chemistry	27.7	23.1	42.4	16.9	19.3	33.0	31.9	31.4	25.5	27.2	19.1
Electric-Electronic	22.1	16.9	8.6	13.7	11.2	16.2	24.9	22.5	8.7	38.5	48.3
Mechanical	50.2	60.0	49.1	69.4	69.5	50.8	43.2	46.1	65.8	34.3	32.6
1993-99											
Chemistry	27.9	27.4	41.9	21.8	24.0	35.8	36.3	37.3	33.3	26.6	21.2
Electric-Electronic	28.2	20.6	8.1	8.8	10.0	17.3	28.1	23.5	11.2	45.5	55.3
Mechanical	43.9	51.9	50.0	69.5	66.0	47.0	35.5	39.2	55.5	27.9	23.5
Tendency											
Chemistry	0.2	4.3	-0.5	4.8	4.7	2.8	4.5	5.9	7.8	-0.6	2.0
Electric-Electronic	6.1	3.7	-0.5	-4.9	-1.2	1.1	3.2	1.0	2.5	7.0	7.0
Mechanical	-6.3	-8.1	0.9	0.1	-3.6	-3.9	-7.7	-6.9	-10.3	-6.4	-9.1

2) From the perspective of the PS, this analysis also suggests, what various authors (Dunning, 1992; Pavitt, 1994) have explained as the existence of a trend towards technological specialization: Europe, Chemistry; Southeast Asia, E-E; while the US, tends to stress the E-E share in a system characterized by multi-technological activities with a high degree of specialization in various fields.

What the study of its patents system suggests is that E-E technologies emerge and predominate while absorbing and permeating other technologies. Thus, innovations tend to gravitate towards Electrical-Electronic (E-E) technologies associated to digital technologies in information and communication. This is true of the US and Southeast Asia, the two regions more economically active during the 90s. On the other hand European countries have kept to the area of Chemistry, traditionally their field of expertise. Among the regions studied Latin America is the only one where the importance of mechanic technology as innovative activity is still alive. This is especially true for Mexico. In other words Latin America keeps itself inside the technological pattern developed in the import substitution period.

The gap of Latin America from the technological frontier is more noticeable when it is compared to the small countries of Southeast Asia. It can also be said that the low activity regarding patenting expresses the limited technological skills of the countries studied in this region. Besides, although a more precise discussion is called for, it can be said that the niches where patents are found in Latin America reflect segments of certain production sectors where technological skills actually exist.

Thus, one observe that the performance of PS in Latin America cannot be understood without considering their learning efforts during the import-substitution phase. During this period, these firms developed requested economies of scale to enable them to compete in the international market after the opening of the economy. This has implied the adoption of plans and blueprints and designs in the domestic market, as well as efforts to improve organisation and increase production capacity. Take for example, the case of some large groups in the chemistry, brewery, and glass containers sectors where not only it has been developed increasing production capacity, but have dedicated their R&D activities to support the knowledge-base of the firms during the import-substitution phase. Most of the paten granted in mechanical activities reflect this story.

Today, most Latin American economies have specialized on the basis of their abundance of factors endowments: natural resources and labour. These sectors where Latin America have specialized after the economic reforms are characterized by low technological opportunities (Breschi and Malerba 1997, Cimoli 2000). Technological opportunities can be differentiated across sectors and reflect the likelihood for innovation in any given effort are associated with different sources. In some sectors, these conditions are related to scientific linkage with universities and other research institutions; for others, the main sources are internal technological efforts, based on R&D and the acquisition of equipment. And yet, opportunities for in other sectors mainly are generated through user-producer relationships.

The specialization shows the existence of two patterns: the Mexican Gulf and the Southern Cone (Cimoli 2000, Katz 2000). The Southern Cone countries (such as Argentina, Brazil, Chile and Uruguay) have intensified their specialization towards natural resources and standardized commodities. These are now highly capital intensive industries with low domestic value added. Firms producing for local markets -the labor intensive and the engineering intensive– are which suffered the most, as a result of trade liberalization and market de-regulation efforts. Conversely, the image that we have is that countries such as Mexico and the Central American nations have greatly globalized their manufacturing and assembly activities based on the cheap labour; and, a new pattern of specialisation in the global production chain is emerging. At first sight, we can refer to the Mexican case as an important example in the region. In recent years, a new pattern of sectors and production lines has been created, and the economic activities are mainly co-ordinated and integrated across geographic borders. For example, Capdevielle et al (1997) argue that the in bond (maquiladora) industry is a central actor in the new Mexican competitiveness. In fact, beginning in 1988 the importance of the maquiladora industries increased steadily: in terms of number of plants and workers employed. The maquiladoras phenomenon poses a problem in the present perspective, considering the effects of their presence on the dynamics of local industry.

Patenting systems: effort and performances

In table 4, we observe a set of indicators revealing not only the level of economic activity but also other aspects that reflect innovative activity.

Table 4, Technological efforts and performances (1999)
Countries and technological indicators

	A	B	C	D	E	F	G
US	152	2.77	74	20	0.9	34.6	10.4
Canada	116	1.61	53	25	0.6	33.7	3.3
Mexico	36	0.34	6	2	0.2	66.2	0
Argentina		0.38					
Brazil		0.76					
Germany	106	2.32	58	21	0.8	37	5
UK	100	1.87	52	29	0.7	33.3	3.2
France	98	2.24	60	20	1	42.3	2.7
Spain	81	0.88	30	16	0.4	43.6	0.2
Portugal	74	0.65	24	7	0.4	65.2	0
Turky	28	0.49	7	4	0.2	64.5	
Greece	66	0.5	20	16	0.2	46.9	
Japan	110	2.91	83	15	0.6	20.9	10.6
Korea	71	2.89	48	5		19	0.7
A) GDP per capita (OECD average=100), B) R&D expenditures as a share of GDP, C) Number of researchers in 10000 economically active population, D) Scientific papers per unit of GDP, E) Government R&D expenditures in the total GDP, F) Government expenditure shares in R&D , G) Index of technological intensity of patents.							

The countries with *converging* PSs have a per capita GDP above the OECD average, while the level of Expense in R & D ranges between a 2.3-2.9 percent of the GDP.

Stable PSs present a close-to-average GDP per capita, while the level of Expense in R and D falls in the range of 1.5-2.2 percent of the GDP. Finally, countries with *divergent* PSs are characterized by a GDP per capita level below half of the average of the OCED. Re their Expenditure in R & D, this is in all cases under the unit as proportion of the GDP.

In the Latin-American region, expenditure in R & D as a fraction of the GDP is relatively low (below one). As we have seen these countries have *divergent* PSs; the same holds true for the average low-income European countries (Portugal and Greece). This contrasts with North America and Southeast Asia whose level of R & D Expenditure is close to three percent of the GDP. Europe, it has been pointed out, is divided in two groups: those with an R & D expenditure relatively high and similar to the US and those with a low income per capita that present a relatively low expenditure in R & D, below one. In countries with low efforts in R & D expenditure, this is due specifically to the low contribution by the private sector. At this level, we can state that R&D efforts tends to reflect also the production specialization of each country and its industrial structure. Here, again the specificity of Latin American ones, which are specialized towards natural recourses and cheap labour.

The same asymmetry is shown in columns three and four enlisting the number of researchers in the work force by region and country and the scientific and technical articles published. Both display a low contribution to research and development activities in terms of researchers with trained in this kind of tasks. The last two columns of table 4 show the degree of strength and technological intensity and the same asymmetries appear: high value for industrialized countries with *converging* PSs and weak in countries with *divergent* PSs like Mexico.

Table 5 relate the performance of PS through our taxonomy developed above and the main features of innovation system in the different countries with particular attention on Mexico. Here, we introduce a broad view of the linkages that exist between the nature of the NSI inasmuch as the function of their institutions and their legal frame are oriented towards an upgrade in performs of their systems.

Converging PS (US, Japan, Korea, Taiwan and Germany): displaying a strong innovative activity especially—although by no means exclusively—in E-E technologies. These PS are linked to solid NIS (high R and D Expenditure, adequate human resources and a growing participation of the private sector) creating a dynamic impact in the USPTO and supporting its strength in the creation of more articulated system to promote innovative activities. Besides, these countries are the ones that establish competition with transnational companies from Europe and the US displacing them through their level of patenting in the USPTO. Stable PS (European countries with high income levels—except Germany—and Canada): showing a considerable innovative activity in Chemistry and less dynamic in E-E. These PS are linked to solid NSI that are nonetheless technologically dated vis-à-vis the emergence of the new paradigm based on E-E. (Although there are some areas in Chemistry, like pharmaceuticals, utilizing state-of-the-art technology). Divergent PS (Spain, Mexico, Brazil, Argentina, Portugal and Greece): displaying a low domestic innovative activity. Their inventive activity persists, especially—but not exclusively—the one associated to mechanic technologies and in some cases to Chemistry. These PS are linked to still unsound NIS (low Expenditure level in R and D, unskilled human resources and low participation of the private sector). Their penetration in the USPTO is very low in the last three decades and there were no new impact made to the regulatory frame. In short, the nature of NIS with a low degree of integration linked to divergent PS is the transfer of technology from abroad. As we have seen the Mexican economy is some kind of paradox: while sharing several macro-economic features with Korea (dynamism in exports with a high technological content, economic growth, etc.) its innovative performance is weak. This is the subject of the following section.

Table 5 Innovation systems and patenting pattern

Patent system	Efforts of innovation system	Insertion in the USPTO
Convergent US, Canada, Germani, Japa., Korea	Higher expenditures in R&D High share of firms expenditures in R&D Surplus in the technological balance A well developed system to support human resources Virtuous networks between firms and institutions Export oriented to product with high technological content	Increasing Increasing E-E technologies, Chemical stable and decreasing in mechanics
Stable France, UK	Higher expenditures in R&D High share of firms expenditures in R&D Deficit in technological balance A well developed system to support human resources Exports oriented to product with medium technological content	Decreasing Increasing E-E technologies, Chemical stable and decreasing in mechanics
Divergent Mexico, Brasil Venezuela, Spain	Lower expenditures in R&D Lower share of firms expenditures in R&D Deficit in the technological balance A weak institutional system to support human resources Weak networks between firms and institutions Export oriented to product with low technological content	Non important Non significance of E-E technologies, stable mechanical, increasing in chemical

Incentives to patenting in the Mexican innovation system

Mexico has accepted the TRIPs-WTO norms, together with the consolidation of the trade reform which began during the second half of the 1980s, and which concluded with the signing of NAFTA and Mexico's membership in the OECD. The IPRs that correspond to the previous industrial property law (1976) have changed radically. The new law incorporated most of the reforms carried out between 1987 and 1997 in such important issues as: (a) a breeder's rights; (b) an integrated circuit's layout design; (c) industrial secrecy; (d) computer programs; and (e) industrial designs. Under these circumstances and considering the characterization of the core patent cycle as granting, protection and use (ONU, 1990; Doer, 1999), we can briefly describe the main institutional changes. The changes in the granting of patents (1991) included new areas of patenting (pharmaceuticals, bio technological and chemical products), as well as the acceptance of the novelty test from the Patent Cooperation Treaty (PCT). The changes in protection were based on the duration of the period of patent protection: this period was ten years in 1976, and it was extended to twenty years in 1991. As for use, the importing of a patented product was again incorporated in 1991.

This right to exploit patents was the center of a controversy during the 1970s, given that it would permit transnational companies to import patented products without having to produce them locally.

Comparing the evolution of patenting activities in two periods, before trade liberalization (1982—87) and during the process itself (1988—99), we can state that: (a) before trade liberalization, patent applications by residents and non-residents decreased; (b) during the process of liberalization, non-resident applications grew considerably, while resident patenting continued its tendency to decrease. As a result, there was strong growth of patenting by non-residents, compared to total patenting. The United States is the country that has increased its participation the most (60 per cent), despite a decrease during the 1995 crisis. Europe and Japan follow. In this context, two important trends can be observed: (a) the flow of total and non-resident patent applications is closely linked to domestic and foreign direct investment during the 1978—96 period; and (b) there is no significant relation between resident patenting activities and the evolution of total private sector investment.

Launched in 1994 NAFTA (North America Free Trade Agreement) exerted decisive influence on the behavior of residents and non-residents patents flows in Mexico (Aboites and Soria, 1999). Residents: the average annual rate of applications flow in this ambit during the first stage (1981-1989) was 3.6 percent while during the second stage (1990-1997) the decrease was considerable (-7.7). Clearly there was an important fall regarding patenting activity among Mexico residents. The flows of non-residents were only of 2.2 during the first time subdivision while for the second the arg for these external agents reached an unprecedented rate in Mexican economy of 34 percent. External applications for patents did not register any significant changes in Mexico. During the first time subdivision the flow went up 3.3 percent while during the second subdivision it reached 4.9 percent. This confirms our categorization of the Mexican PS as a *divergent* one[2].

Patents granted in Mexico for MNCs (1980-1992)

Sectors	1980-1982	1983-1986	1987-1989	1990-1992
1 Chemistry	1,393	1,240	1,106	1,679
2 Electric-Electronic	1,009	631	466	414
3 Non electrical machines	851	672	632	993
4 Transport	170	134	124	176
5 Other technology	183	141	137	243
Total	3,606	2,818	2,465	3,505

Source: Innovación propiedad intelectual y estrategias tecnológicas, México (1999)

[2] The number of applications from residents was characterized by a permanent and slow decline, a trend that would not display any modifications due to the great changes in the economic incentives, the negotiations of NAFTA nor the actual launching of the Agreement. While in 1983 applications from residents represented 16 percent of the total, by 1994 they amounted only to 4 percent. The average annual rate of residents was of –3.1 percent and the one corresponding to non-residents was 13.2 percent.

In synthesis, a growing preeminence of the non-residents applications is noticeable. Moreover, a large part of the problem can be related to the role played by the transnational companies that use used patents to block competition and to protect their markets (Aboites and Soria 1999, Aboites 2001). This trend is markedly accentuated from the first year of negotiations of the NAFTA and with the changes in the legislation of intellectual property rights (1990 and 1991 respectively). Thus, in 1983 non-residents applications represented 84 percent of the total, while by 1999 they would reach 96 percent. Moreover, it could be said that during the negotiations and launching of the NAFTA, a strong flow of non-residents patents and a constant drop of activity form individual inventors and businesses characterized the Mexican PS. Nevertheless this situation does not seem to bear any relation with the NAFTA.

3) During the 1991-4 period, there was growth of applications by all patent-holders, whereas in the 1994-6 period there was a substantial decrease in three types of patent-holders (aboites 2001). Between 1991 and 1994, the most important growth in patent applications was from firms, universities and research institutes. Individual persons had the lowest growth. Between 1994 and 1996, there was an overall decrease, universities and research institutes being the most affected. It is important to point out that firms are the main patent-holders, since eight out of ten patents belong to firms, specifically transnational companies

4) Chemicals, metal products, machinery and equipment are the sectors in which 88 per cent of patent applications are concentrated. They are also the most active sectors in the number of patent applications during the 1991—4 period. In the chemical sector, the growth of patent applications is linked to PEMEX, the government-owned petroleum monopoly, as well as to the important petrochemical industry that has developed around this state-run company. The rest of the manufacturing sectors, specifically the traditional ones (food and beverages, textile, leather, etc.), have less relative importance and less activity in patent applications. During the 1995 economic crisis, the manufacturing sectors *registered* reductions; R&D intensive sectors with a predominance of multinational firms (pharmaceuticals, biotechnology and others) were noteworthy because of their dynamism in patent applications.

Our background here is that innovation has to be considered and defined as an interactive process whereas firms almost never innovate in isolation (in this context, strategies alliances, and interactions between firms, research institutes, universities and other institutions, are at the heart of the analysis). Some new technologies are being patented in the Mexican patenting system. None the less, this non-resident patenting, for example, in pharmaceuticals and other sectors does not show a spillover that has influenced domestic innovative activity . This fact appears to show that growth of non-resident patenting does not generate an upgrade in local innovative activity or in the creation of networks that contribute to the strengthening of the nation's technological capability (Arvanitis. and Villavicencio (2000), Gonsen,. and Jasso (2000)). For example, this is particularly true for the pharmaceutical industry, where there is no incentive for R&D, or for linkages between universities and domestic companies related to the generation of new molecules that are national discovery. Another characteristic that distinguishes the system of patents registered is that applications for patents in electronic technology are relatively low. In effect despite the boom in electronic exports, there has not been a significant increase in patenting activity and R&D efforts.

Asymmetries between Korea and Mexico

Korea it is an interesting case that can be compared with Mexico, in particular Korea was in the "watch list" of the US trade representative fro a long time. "It is mainly argued that Korea's intelecttual property right law does not meet standarts set out by WTO Agreement on TRIPS. Most, notable, Korea does not provided for TRIPS consistent protection for pre existing works and sound recording. The US have also raised concerns with the level of patent protection for pharmaceutical and the protection of data in Korea, as well as with Korea's market access restriction on pharmaceutical products and on motion picture and cable TV programming" Combe and Pfister (2000). In other words, the Korean PS is characterized by a set of incentives that support the diffusion of innovation and protect the technological capabilities achieved in the industrialization period.

In the case of Korea only the second time subdivision (1990-1997) is analyzed due to lack of any more information from the OECD. The trends registered in this subdivision are striking: applications from residents increase at an average annual rate of 51 percent; in other words, the highest of all the countries studied. Dynamism from non-residents is also considerable: 12 percent. It may be observed that at the beginning of the period under study, residents submitted less application for patents than foreigners, but at the end (1997) they greatly surpassed them. Undoubtedly Korea's patents system is *converging* and the most dynamic in the last decade. Add to this the impressive flow of external applications in this country (43 percent), which, as we shall see later, has spread over industrialized countries, particularly in the US economy where the amount of patents granted to Korea is comparable to the United Kingdom's. Moreover, the Korean PS increase considerable the number of patent granted in the USPTO (see, table 4).

The previous section suggests that in countries with converging PSs exporting is strongly associated to the innovative activity reflected in patents. Mexico is renowned by a strong dynamism in exporting manufactured goods comparable to Korea's. Nevertheless the coefficient correlating patents with exports of manufactured goods shows pronounced differences. In fact, in the coefficient of residents' patents-exports of manufactured goods Mexico reaches 0.47 as mentioned above while Korea has 66.0 (US, 22; Japan, 84). But the quota of Mexico's manufactured goods exporting market is increasing in high technology (3.3 of the OCED) close to Korea's 4.6.

Besides Mexico is strongly deficient in its technological balance (Aboites and Soria 2000). This suggests that while in Korea exporting is associated with innovative activity, the same does not hold true of Mexico. This is an important topic that we shall discuss both in the following paragraphs and in chapter four where the relation between exporting success and innovative activity in Mexico is dealt with in depth.

This set of contrasts between Mexico and Korea should be looked into from the perspective where Korea is seen as an economy with a converging PS and a NSI that has consolidated its upgrade of technological capabilities in the last decades. A fact that explain the differences between both countries is entailed in the concept of selective dynamic intervention, derived form the experiences of developmentalists. For example, one of the keys to their success has been the ability to program the level and composition of non-competitive intermediate and capital goods. For example, the case of South Korea, where quotas, directed credit and targeting were used in order to select those industries that were to provide foreign exchange through exports. The industries whose exports were promoted were those in which the country possessed a static comparative advantage whereas the industries which enjoyed of protective policy were subject to the condition of developing a dynamic comparative advantage. At the aggregate level, thus, it was also possible to obtain a balanced portfolio in terms of sources and uses of foreign exchange. Within the industries supported to develop dynamic comparative advantages, it seems that the major actors in technological learning have been large business groups - the chaebols- which have been able at a very early stage of development to internalize the skills for the selection among technologies acquired from abroad, their efficient use and adaptation, and, not much later, have been able to grow impressive engineering capabilities (Kim 1993). This process has been further supported by a set of institutions and networks dedicate to improve and upgrade human recourses (Amsden (1989)).

Performance of Mexican Innovation System

After the trade reform, Mexico has substantially increased its participation in the world arena, in terms of exports as well as imports. Most of the surviving and efficient firms (both MNCs and large domestic firms) have increased their exports (components for automobiles, chemicals, plastic products, glass, beer, electronics, steel, cement, etc.) and imports of intermediate and capital goods. The image that we have is that Mexico is a country in which production activities are highly globalised and that a new specialisation in the global chain of production is emerging ((Capdevielle, Corona and Hernandez (2000), Unger and Oloriz (2000)). Nonetheless, all types of firms have some integration with countries that lead in international trade and technological innovations, thus becoming dependent on imported technology, as well as on imports of the most technologically dynamic products and intermediates. In a similar context, the majority of the transnational companies patenting is for commercialisation and protection of their product locally. More general, there are a number of general factors in the Mexican NIS that can explain the impacts of the superimposed incentives provided by the new trade and the IPRs regimes (Cimoli 2000).

R & D efforts

Mexico’s R&D efforts are rather poor in comparison to those at the technological frontier. Moreover, R&D is highly concentrated in the export sectors (automobiles, glass, cement, office machinery and computers, electronic equipment, etc.). R&D effort principally focused on addressing the modernisation of production processes and improvements in production organisation and product quality. As for to sources of new technological knowledge, the vast majority of firms rely almost exclusively on their internal sources. In fact, regardless of the sectors in which firms operate, they have not developed co-operative R&D efforts with other firms and institutions. Furthermore, in none of the technological sectors have firms made significant expenditures on R&D, except for those that are export oriented, and these firms principally have invested in improving processes, organisation or quality. As a matter of fact, the pattern of R&D efforts -which have been scarce and scattered- and other modes of technology transfer has been mainly dominated by a higher integration of imported inputs in most competitive sectors (Capdevielle, Corona and Hernandez (2000)).

FDI and local technological efforts

Foreign direct investment (FDI) refers to activities and decisions taken by multinational enterprises (MNEs). These activities and decisions, developed in consideration of international production, exert a strong influence on the direction of trade flows, scale and content as well as on the trade specialisation, competitiveness and foreign trade balances both of the host and home countries. This is the case of a host country like Mexico. In fact, in large part, the Mexican patterns of trade specialisation and performance (for example, international competitiveness) can then be analysed as the outcome of the processes that result as the MNEs decision on the localisation and quality of FDI. In this context, regional integration through the NAFTA has played a crucial role as an institutional regime or framework that supported the incentives for the MNEs. Today, technological developments occur mainly in the home bases of MNEs and only a small portion is transferred to countries like Mexico. This process determines, on the one hand, that Mexico participate actively at the globalization of production and, on the other hand, that its participation in the globalization of scientific and technological activities is very poor. As companies transfer only some of their R&D activities to Mexico, we can expect that the present concentration of corporate R&D will by and large lead to a even stronger international divergence of technological development. Internationalisation of R&D is developed within developed economies and regions with revealed technological advantages. Technological cooperation between firms seems, in practice, to exclude firms that do not already have an established reputation within the developed economies. This view supports results obtained for empirical research on the organisation of research activities in multinational firms, here is noted even multinational companies perform most of their innovative activities in the home country (Patel and Pavitt (1991), Cantwell (1989) and (1997), Chenais (1988) and Freeman and Hagedoorn (1995), Unger and Oloriz (2000)).

Most of the production activities in Mexico have increased their demand for knowledge and technology provided by foreign sources. Our evidence indicates that firms that has modernised its exporting plants, which suggests that industrial adjustment has occurred preferentially through process innovation such as the improvement of production organisation, improvement of skills and adaptation of machinery and equipment - not the renewing of fixed capital - which would permit the MNEs and large domestic groups to achieve a higher competitiveness performance. Moreover, there are three main reasons why the dynamics of inter-industry flows simply is not functioning to improve R&D efforts and linkages with the local institutional framework. For example, maquiladora operations dominate the production of science based components, thus allowing for very limited links and flows to other domestic suppliers of intermediates. Particularly, when the analysis is developed for the most recent years, it seems to confirm how the maquila industry is one of the leading actors of industrial modernisation. The diffusion of this type of industry introduces only very weak connections with the domestic productive firms and institutions (Unger and Oloriz (2000)). The "maquila innovation system" mainly support and stimulate the networking activities in the abroad firms and institutions, reinforcing thus knowledge and technological advantages in developed economies.

The pattern of innovative activity contrasts with the orientation in the production of the different kinds of businesses. In Mexico companies whose production is basically geared toward exporting do not carry on neither innovative nor patenting activities. When comparing the behavior of patents systems in five technological sectors a widening gap between the electric/electronic sectors is observed. This is important because a very significant part of the exporting maquiladora industry is related to electronic accessories or automotive parts closely related to this type of technology. Chemistry is the fastest growing technological patents sector in Mexico while in the US it displays a low proportion and a moderate growth. This is the case of the exporting bond industry (maquiladora) whose most outstanding feature is the weak link between production and innovation. Thus, its technological externalidades do not display any proof of having contributed in any way to the construction of technological skills or the strengthening of the NSI .

Specialization in assembly activities

There are several pointers showing the links between the export activity of maquiladora-manufactured goods and the rest of the economy. We will present only two. First, according to data from INEGI during the last decade approximately 95 percent of the raw materials required by this sector were imported. This clearly shows the lack of connection between the manufactured-goods exporting sector and the Mexican production system. Second, the resource most utilized by the manufactured-goods exporting sector is work. According to OIT the low established salaries paid to workers in maquiladoras (in 1998 the established salaries paid in the Mexican maquiladora industry were equivalent to 9 percent of what is paid in the US and to 14 percent of what is paid in France) reflect the low technological complexity of the work tasks as well as the workers' low level of qualification. In other words, when reviewing these two types of relations with the national production sector it is clear, as several authors (Capdevielle, Corona and Hernandez (2000)) have explained, that the most deeply rooted link established by the maquiladora industry is with the less qualified segments with the lowest salaries in the country's work market. It is convenient to bear in mind that the vitality of the maquiladora industry does not depend on the internal market but on the integration of the plants installed within the national borders with production processes abroad, especially in the US. Finally, it should be stressed that during the last decade approximately7 25 percent of the FDI was associated with this industry. In short, the maquiladora industry contributes decisively to the exporting of manufactured goods without significantly associating with the national production sector; it is tightly associated with that sector of the work market characterized by its low qualification and salaries; it is an important source of FDI to the national financial system (Capdevielle, Corona and Hernandez (2000)).

Substitution of local technological sources

The imported equipment used throughout the industrial system replaces –as is a surrogate for- the learning capability that could accumulate in specialised domestic suppliers of equipment in a well integrated industrial system. The main changes could be observed in the modes of how sectors and the type of firms (considering Foreign Firms and Non Foreign Firms) are inter-inked with foreign production networks and sources of technology. Particularly, the pattern related to R&D efforts and other modes of technology transfer mainly has been substituted by a greater integration with imported inputs, stronger linkages with foreign engineering services and institutions (as universities and other research institutes) for the most susseful exporting sectors. Their direct contribution to R&D and technology transfer is not substantial.

The personnel employed in R&D activities, quality control and local adaptation of design mainly interact within multinational firms where they work and, furthermore, those firms are characterised by reduced linkages with the domestic higher education institutions, local research centres and laboratories. In this context, for example, universities show an increasing effort to improve and create linkages with the production system. But those efforts are inhibited by two principal factors. On the one side, we have the bureaucratic organization of most public universities and, on the other, we see lack of the demand form the industrial sector -the modernised one and the more science based- which demand «knowledge» from institutions and research centres abroad. In the long term, these ideas are consistent with a depreciation of competencies of local human capital and adverse incentives to develop linkages with local research centres**.**

Inhibition of local networks

The interaction between firms and the local institutions that produce knowledge is very poor, a fact that is most keenly felt by those companies belonging to the science-based sector. The results show that domestic firms consider internal sources of knowledge as more important for their innovative activities than external sources. Within the production system the activities of engineers, technicians and the experience of the labour force constitute the most relevant sources of knowledge, particularly for firms within the scale-intensive and science-based sectors. According to firms, users also are an important source of technological knowledge, especially in the specialised suppliers and supplier-dominated sectors. Public sector or university research centres are not a relevant source of information for Mexican firms. This is rather remarkable fact in the case of firms within the science based sector, since this sector is strongly linked with such centres in the more developed countries. This process is reinforced by the protective incentives introduced by the homogenisation of the IPRs regime.

A substantial and widespread perception is that: networks are a powerful engine for innovation systems. Regarding recent parables of globalisation and liberalisation, it could be conjectured that the benefits generated by knowledge intensive networks are not equally distributed. Moreover, the specialisation of production supports a system of networks where the demand for knowledge and innovation is continuously addressed towards advanced economies. This increases their capabilities of capturing the benefit and advantages. At first sight there thus appears a contradiction between the theoretical vision that support the idea that countries capture the benefits of globalization and most empirical evidences on the increasing gaps in the capabilities of capturing the benefit of networking and innovative activities (Cimoli 2000).

In addition to the above, the analysis of the effectiveness of the linkages supporting both knowledge flows and, hence, innovation processes, is complicated by the presence of all those informal types of relationships between organisations and institutions (and among both sets of actors) that in the standard literature fall under the heading of “externalities”. Clearly, further investigations shall be required in order to provide a more solid basis to this representation of our structure. Nonetheless, we believe that such a structure would be helpful in understanding the mechanisms by which networks determine the success and failure of innovation. However, recent advances in the economics of innovation have highlighted the powerful role of externalities in the generation of new technologies and a virtuous development path.

These points have all inhibited local networking activities. The conclusion to be drawn from this section is that the effects of the stimuli generated by the openness of the economy are starting to wear out and, furthermore, local networking activities do not have sufficient support, in terms of linkages between the different agents in most of innovation system in Mexico. In others words, the production system has modernised a small part of the economy, due to the effects derived from the opening-up of the economy. However, this process has not been accompanied by an increased effort to stimulate the creation of local networks, such as: the non-market system of linkages, a business culture and institutions that enable firms to interact with each other. Moreover, the new IPRs do not stimulate the local innovative activities; on the contrary, they have been inhibited radically.

Conclusions

The incentives by the IPRs does not fits properly in the case of developing economies; particularly, in those that have adopted liberazation policies and market oriented reforms. Countries do not start from the same line. Thus, developed countries with large advantages exploit static benefit from trade with developing economies. In other words, we have here that the advantages IPRs homogenization is asymmetrical: only developed economies benefit from the static and dynamic ones.

This asymmetry clearly reinforces the prevailing gap between local and external technological capabilities which now benefit further from the globalization process. These interaction between the incentives promoted by economic reforms and IPRs regime are seen in a complementary perspective as responsible for the occurrence of what has been called “lock-in by historical events” and “self reinforcing process” (Arthur, 1989, David 1994). Liberalization and globalization of markets cum the homogenisation of the IPRs regime in a context of competing firms under increasing returns to scale mechanisms can eventually reinforce the technology gap between nations, if the ‘destruction’ of local capabilities is not compensated by the diffusion of knowledge transferred (or diffused) by the globalised firms.

In developed economies, the IPR regimes promote R&D efforts and linkages between different type of components of the innovation system. Thus, the main difference between developed and peripherical economies lies in the effect that the protection of IPR has on the innovative activities. In Mexico, there has been a reduction in domestic patenting. Thus, despite the increase in non-resident patents, there is not an local adequate diffusion of the technological knowledge that arrives in Mexico from abroad. This suggests that the existing networks are not stimulated for the diffusion of this type of technological information towards the national agents, which is a distinguishing characteristic of the Mexican innovation system. This leads us to conclude that there are two factors that block the diffusion of technology that is codified in patents, so that it does not reach the domestic productive system: (a) the majority of the transnational companies patenting is for commercialization (by importing patented products or to block competition); and (b) the transnational companies support their R&D effort at home and, preferably, develop network with institutions and high technology firms in developed economies. An important conclusion that is derived from the previous statement is that NAFTA met expectations of increasing foreign direct investment, but the same is not true for the local diffusion of technology flows. In other words, the transnational companies mostly patent to commercialize, thus favoring the creation of networks abroad. Thus, we can affirm that the changes in intellectual property rights in Mexico have strengthened the transnational companies' strategies by permitting the diffusion of their innovations through trade, instead of through the creation of local innovation and technological networks.

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